Perforator Flaps in Head and Neck Reconstruction

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ABSTRACT

This article attempts to put perforator flaps, as they apply to head and neck reconstruction, into perspective. The importance of existing flaps is emphasized. Specific indications for perforator flaps are highlighted. The deep inferior epigastric artery perforator flap is used as the flap of choice for subtotal glossectomy defects by the authors. The anterolateral thigh flap is the most common flap currently used. Indications for its use are highlighted. Facial artery perforator flaps are introduced, and their roles as local flaps in head and neck reconstruction are highlighted. With our better understanding of vascular anatomy, existing flaps such as the submental flap have been recategorized as perforator flaps. Its role in reconstruction, particularly of lower facial defects, is discussed. Finally the internal mammary artery perforator flap is described and its advantages over the deltopectoral flap and the pectoralis major flap outlined.

KEYWORDS: Head and neck reconstruction, facial artery perforator flap, DIEAP flap, anterolateral thigh flap, submental flap, internal mammary artery perforator flap

This article describes some of the applications for perforator flaps in the head and neck. It is important for the reader to realize that although perforator flaps have expanded our armamentarium and afforded us more options in choosing an appropriate reconstruction for a given defect, there are still many traditional flaps that continue to play a role in head and neck reconstruction. In this article we attempt to put into perspective where perforator flaps fit in our current practice and how they can be utilized to best effect in the head and neck. The discussion in this article is confined to areas within the head and neck where perforator flaps play a definite role. Because of the prominence of this region, defects of any kind in the head and neck area are in full view and entirely open to scrutiny. For this reason the demands on our reconstructive skills are, in some ways, greater than they are elsewhere in the body where function is less specialized cosmesis possibly of less significance. Head and neck reconstruction therefore presents unique challenges to the reconstructive surgeon. Although reconstruction of specific areas of the head and neck will be discussed in detail, there are general principles that apply to all regions. The principles that guide us may seem obvious but it is nevertheless important to list them:

1. We should wherever possible replace excised tissue with similar tissue. This generally means local tissue, and although for various reasons this may not be available, we should, whenever possible, use it. Local tissue provides the best match both cosmetically and functionally. In the head and neck the recent description of the facial artery perforator flaps has increased our ability to do this and will be discussed in more detail.[1]

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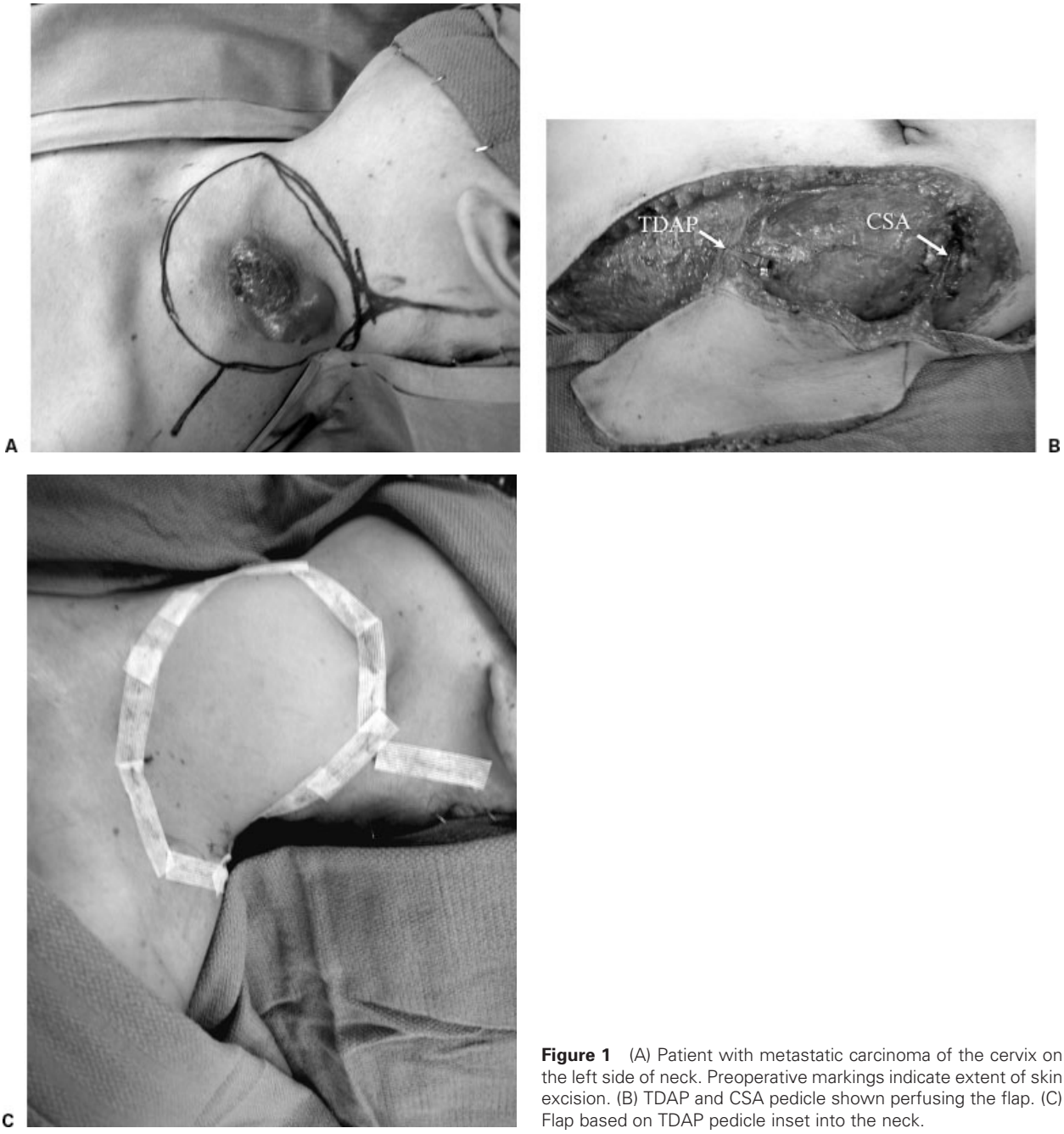


Figure 1 (A) Patient with metastatic carcinoma of the cervix on the left side of neck. Preoperative markings indicate extent of skin excision. (B) TDAP and CSA pedicle shown perfusing the flap. (C) Flap based on TDAP pedicle inset into the neck.

2. Our reconstruction should not interfere with treatment of the patient's main condition. If, for example, the defect is a result of cancer ablation and the patient requires some sort of adjuvant therapy, we should ensure that our reconstructive choice is likely to heal satisfactorily in order not to delay that process. Similarly we should not embark on an elaborate reconstruction until we are sure that we have adequately dealt with the presenting problem. In some circumstances it is prudent to wait for final pathology even if that means temporizing with the wound until that is available.
3. Although the simplest treatment is not necessarily the best, we should nevertheless choose an option that has a reasonable chance to succeed. Technical feasibility alone is not an indication for any procedure.

THE ROLE OF PERFORATOR FLAPS IN HEAD AND NECK RECONSTRUCTION

Probably the main impact of perforator flaps in the head and neck region is to increase the sophistication of our reconstructions as well as to provide us with more choices.[2] Figure 1 illustrates this concept. This patient presented with a fungating lesion on her neck and required a modified radical neck as well as excision of all of the overlying skin (Fig. 1A). This lesion was a

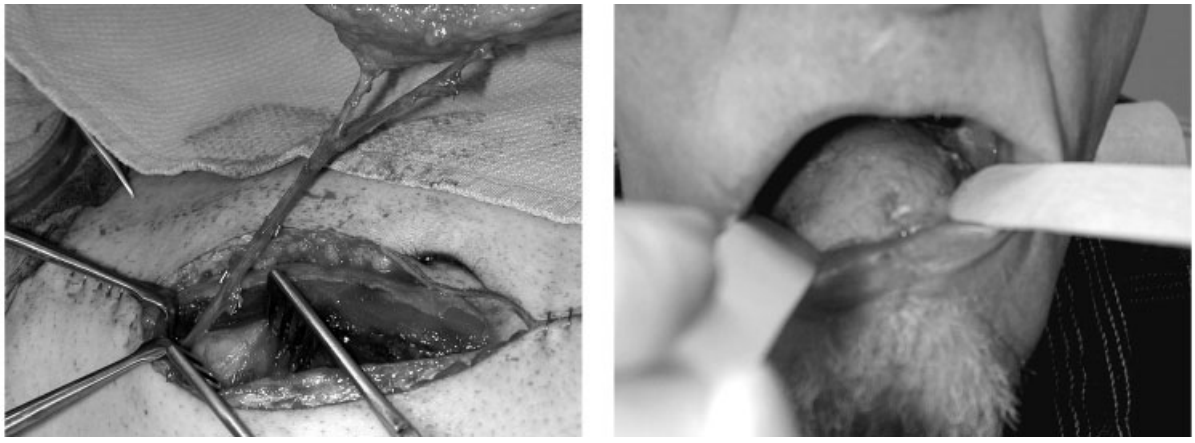


Figure 2 (A) Vertically oriented DIEAP flap elevated on two perforators. Note the length of the pedicle. (B) Bulk of DIEAP flap retained following reconstruction of subtotal glossectomy defect followed by postoperative radiation.

metastatic cervical cancer! This surgery was therefore palliative. Although there are many ways in which this defect could be reconstructed, we elected to use skin from the scapular region. Figure 1B shows the blood supply of the skin raised. Both thoracodorsal artery perforator (TDAP) and circumflex scapular arterial (CSA) systems are shown, supplying essentially the same segment of skin. In this case we had the choice of which pedicle to use and chose the TDAP because it entered the midportion of the flap and was therefore geometrically a better fit for anastomosis to the superior thyroid artery, which we had chosen to vascularize the flap. Obviously either flap would have been appropriate. However, with our increased knowledge of flap vascular anatomy, our versatility in optimizing the reconstruction for any given defect is greatly enhanced. With this in mind we would like to present specific areas of reconstruction where perforator flaps have either become our first choice or where they present an attractive alternative to other reconstructive options.

THE DEEP INFERIOR EPIGASTRIC ARTERY PERFORATOR FLAP IN HEAD AND NECK RECONSTRUCTION

We have used the designation deep inferior epigastric artery perforator (DIEAP) rather than the previously used deep inferior epigastric perforator flap in accordance with our previously published classification system for perforator flaps.[3,4] Although we generally think of the DIEAP flap in terms of breast reconstruction, it has other useful applications, particularly in the head and neck.[5] In this region the one specific application in which it has become our flap of choice is in reconstruction of the subtotal glossectomy defect. For this application the flap can be oriented horizontally or vertically. Figure 2A shows a vertically orientated DIEAP flap being raised and illustrates the advantage of the long pedicle that is afforded by dissection of the perforator from the rectus muscle. A specific advantage of the flap for subtotal glossectomy reconstruction is the bulk that it provides. This bulk is important to optimize the patient's chance of swallowing while minimizing the risk of aspiration. With inadequate bulk in the floor of the mouth, the floor acts like a funnel. Constant drainage of saliva and liquids into the pharynx increases the risk of aspiration such as to make it practically inevitable. A bulky flap to replace the tongue allows obturation of the flap against the palate to reduce the risk of funneling and aspiration. The rectus abdominis myocutaneous flap provides similar bulk to the DIEAP. In our estimation there are two distinct advantages to using a DIEAP rather than a rectus. The first is the reduced donor morbidity that results from preservation of the completely innervated rectus muscle. Although there is, so far, little in the literature to support that claim, it is nevertheless our clinical impression and is the subject of ongoing study. More importantly, however, is the issue of bulk. The bulk of the DIEAP flap consists of the skin and subcutaneous fat. This is relatively constant and does not change a lot with time, even in the presence of radiation. The rectus flap has a significant muscular element that adds to the bulk of the flap. Although on the surface this may seem an advantage, the unpredictability of the degree of muscle atrophy means that the ultimate outcome is also somewhat unpredictable. Sometimes the bulk is just right; other times the initial bulk undergoes significant atrophy leading to inadequate volume of the ultimate result. With the DIEAP flap the ultimate bulk is more predictable (Fig. 2B). Although we have used this flap for other applications in the head and neck[5] the subtotal glossectomy is the single defect for which it is our first choice.

As with many flaps, the DIEAP flap has the advantage that it can be harvested at the same time that tumor ablation is being performed. Our preference

is to raise the flap in a vertical orientation (see Fig. 2A). Flap perforators are carefully identified during elevation, and the largest vessels are then dissected through the rectus muscle to the deep inferior epigastric vessels. These larger perforators are consistently found in the periumbilical region. One of the reasons we use vertically oriented flaps is that the entire flap is placed in zone 1 of the DIEAP circulation. This orientation does restrict flap width to some degree; however, as less tissue is generally required in head and neck as compared with breast reconstruction, this is not generally an issue.

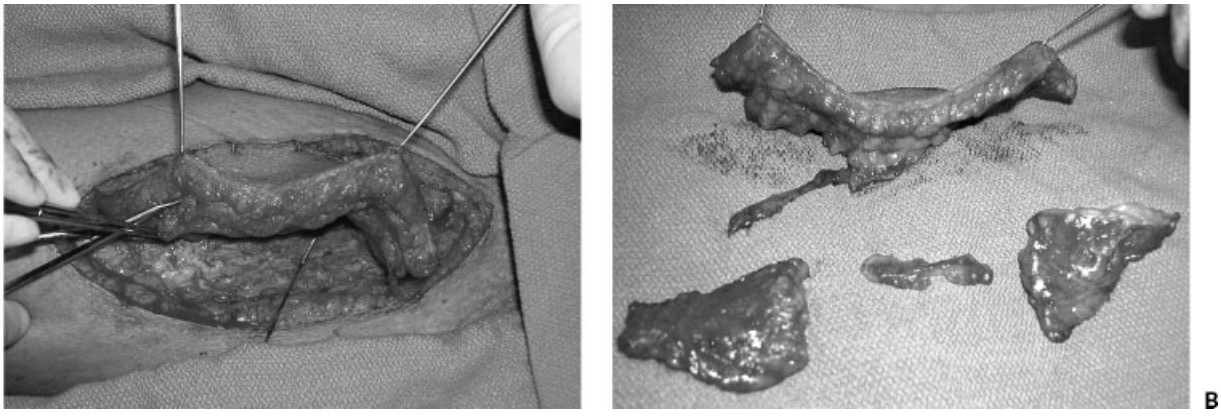
THE ANTEROLATERAL THIGH FLAP

The anterolateral thigh flap based on the lateral circumflex femoral artery perforators has become the most commonly used flap for head and neck reconstruction in our practice.[6] It is discussed in detail elsewhere in this issue and will not be discussed in detail here. However, it is important to acknowledge the role it plays in head and neck reconstruction. In our practice it has become the flap of choice for floor of mouth as well as for hemiglossectomy reconstruction (Fig. 3). We also use it extensively for resurfacing large defects of the face. There are several criticisms that potentially detract from its utility. It is generally accepted that color match may be suboptimal. It has been our experience that this also applies to flaps such as the scapula that are reputed to have a better color match with the face. One advantage of the anterolateral thigh over the scapula is the fact that simultaneous flap harvest and tumor ablation can be performed when using the anterolateral thigh. Another criticism that is regularly cited regarding the use of the anterolateral thigh flap in head and neck reconstruction, particularly in the Caucasian population, is the fact that the thigh may be bulky in those patients. This has not been our experience with the typical head and neck patient. In patients in whom the flap is thick, it is feasible to thin it.[6] Figure 4 shows the degree of thinning that can safely and easily be performed.

Figure 3 Hemiglossectomy defect reconstructed with anterolateral thigh flap.

THE FACIAL ARTERY PERFORATOR FLAP

Facial artery perforator flaps are an example of a freestyle local perforator flap.[7] Such flaps have been described throughout the body including the torso,[8] the lower limb regions,[9] head and neck,[1] and upper limb.[10] Many of the actual local perforator flaps are related to previously know geometric (random) or axial pattern flaps as they share a common vascular supply. Facial artery perforator flaps fall into this category. Doppler examination of the facial artery distribution reveals that there are crescendos of sound at intervals along the course of the facial artery (Fig. 5). These represent perforators coming from the facial artery to supply the overlying skin. Using Taylor's angiosome principle,[11] a flap can be harvested based on a single perforator that captures the territory of the adjacent perforator (angiosome). A flap is therefore designed incorporating the vascular territories of two of these Dopplered perforators. The perforator nearest the defect is dissected and the distal one is ligated. The flap is then rotated through 180 degrees to close the defect. Because of the danger of kinking these small vessels, it is important to ensure that the pulse can be found by Doppler after the flap has been rotated into its final position (Fig. 6). Frequently, a small amount of soft



A B

Figure 4 (A) Anterolateral thigh flap being thinned while still vascularized in the leg. (B) Thinned anterolateral thigh flap.

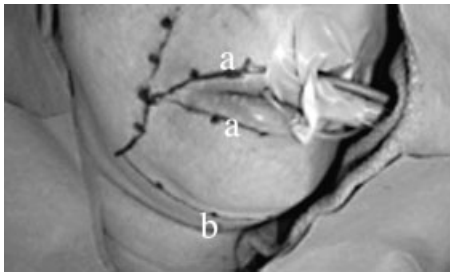


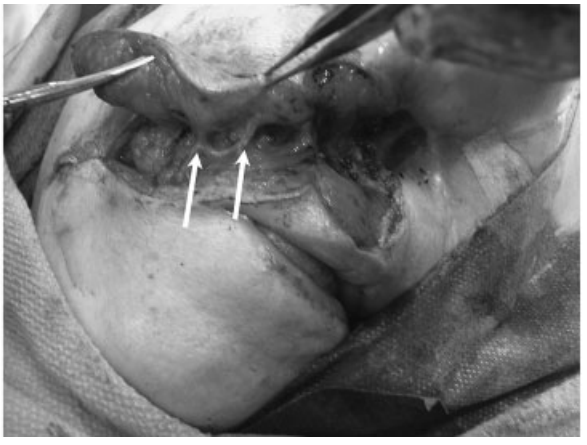
Figure 5 Facial artery Dopplered with areas of increased signal marked with dots. These dots represent cutaneous perforators coming from the underlying facial artery. Note the extension along the labial arteries (a) as well as along the submental artery (b).

tissue left around the perforator can be sufficient to cause an obstructive kink in the pedicle. The degree of rotation through which the flap has to be moved will often determine the amount of dissection that is required. This flap is proving to be a useful addition to our armamentarium, at least in our practice.

Figure 7 illustrates the practical application of this principle. The patient has extensive basal cell carcinoma as a result of radiation for acne as a teenager. She presented with an extensive lesion of her upper lip. She has already has several radical excisions that have necessitated free-flap reconstruction. Most recently she has undergone subtotal rhinectomy as well as resection of her forehead. This was reconstructed with an anterolateral thigh flap with the plan to revise this flap and reconstruct the nose. In the meantime she presented with a new

Figure 6 Patient following wide excision of melanoma reconstructed with facial artery perforator flap turned 180 degrees from nasolabial region. The Doppler confirms that the perforator is still patent following flap rotation and inset.

A



B

C

Figure 7 (A) Patient following excision of basal cell carcinoma (BCC) upper lip. Facial artery perforators have been marked and flap designed to incorporate two perforators. (B) The flap is elevated on the two Dopplered perforators (arrows). Placing a microvascular clamp on one of the perforators reassures the surgeon that the flap can be carried on one. Also persistence of the Doppler signal (as shown in Figure 6) following flap rotation is further reassurance that flap viability will be assured. (C) Appearance 6 weeks portoperatively.

lesion in her upper lip. The defect consisted of a significant portion of her upper lip and was reconstructed with a facial artery perforator flap as shown. This allowed us to effect a reconstruction without resorting to another free-flap, maintaining competence for her upper lip and enabling us to now proceed with further reconstruction of the rest of her face. As well as reconstructing the perioral region, these flaps can also be used to resurface the infraorbital region as shown in Fig. 6.

THE SUBMENTAL ARTERY PERFORATOR FLAP

Though not initially recognized as a perforator flap, it is nevertheless the case that this flap is supplied by branches of the submental artery that either perforate the anterior belly of digastric or run immediately anterior or posterior to it.[12,13] The submental flap is attractive for several reasons: it is local tissue and therefore bears all the advantages of such tissue in terms of texture and color match. The donor site is excellent and easily hidden in the submental region, especially in the older patient.[14] The flap can easily reach the midface, and when used in a reverse manner as described by Kim,[12] can also reach the upper face. It can also be used as a free flap. Harvest of the flap is straightforward.[14] The dissection begins on the nonpedicle side and includes platysma. Once the midline is reached, one can either look for and dissect out the perforators as Kim describes or simply include the anterior belly of the digastric with the flap, thereby ensuring incorporation of the perforators. Though this does add a little bulk to the flap, this extra bulk is not very significant. The submental artery runs transversely over the submandibular gland. The pedicle can generally be seen as the anterior belly of the digastric muscle is elevated. Once identified, it is readily dissected back to its source from the facial artery. The flap is generally tunneled into the facial defect as shown in Fig. 8. If

Figure 8 (A) Twenty-two-year-old patient with melanoma of the upper lip for planned wider excision and sentinel node biopsy. (B) Submental flap raised and tunnel fashioned between neck incision and facial excision. (C) Early postoperative appearance 6 weeks postoperatively. Note flap donor scar hidden in anteroposterior view and no other scars on the face.

greater pedicle length is required, the facial artery can be divided cephalad to the submental branch and mobilized caudally. This maneuver generally yields significant length to the pedicle and increases the arc of rotation of the flap.

THE INTERNAL MAMMARY ARTERY PERFORATOR FLAP

Perhaps the first large perforator-based cutaneous flap to come into widespread use was the deltopectoral flap, often called by its eponym as the "Bakamjian" flap. Jackson recognized that the robustness of this particular flap was due to its unique vascular arrangement deriving from the perforating branches of the internal mammary system.[15] The major disadvantage of the flap is that the donor site usually requires a skin graft and is unsightly. Moreover, the arc of rotation of the flap is such that surgical delay is required if the flap extends over the deltoid region,[16] and this extension is usually necessary for the flap to be useful in most reconstructions. It has a relatively wide base and this also limits its rotation. The flap is based medially and is supplied by perforating branches from the internal mammary artery.[16] The classic dissection of the flap was a subfascial dissection extending to within 2 cm of the sternal border.[17] This would incorporate the internal mammary perforators that supply the flap.

We recently described a modification of this flap in which one or two of the internal mammary perforators, once identified, are dissected through the muscle to the underlying internal mammary vessels. A segment of costal cartilage is removed to gain access to the internal mammary vessels and facilitate mobilization of the pedicle. The internal mammary vessels are divided distal to the origin of the perforators and are further mobilized as far as possible cephalad.[18] This increases the length of the pedicle considerably and allows the flap to be easily pedicled into the neck (Fig. 9). It has the added advantage of allowing primary closure of the donor site. Thus it captures all the advantages of the deltopectoral flap while disposing of all the disadvantages. As with all perforator flaps, the skin paddle can be designed in any direction around the pedicle with the exception that it cannot cross the midline. There are, therefore, several potential flaps that can be raised based on this pedicle (Fig. 10). This flap is particularly useful for resurfacing the neck. Even though there are other flaps that can achieve this, we believe that the internal mammary artery perforator (IMAP) flap provides excellent quality skin cover in an easily pedicled manner without sacrificing muscle, with minimal bulk and with an acceptable donor site. It has the added advantage that it can be raised as a sensate flap based on the anterior intercostal nerves.

Figure 9 IMAP flap isolated on first and second perforators from internal mammary artery. The intervening costal cartilage was removed to allow mobilization of the pedicle.

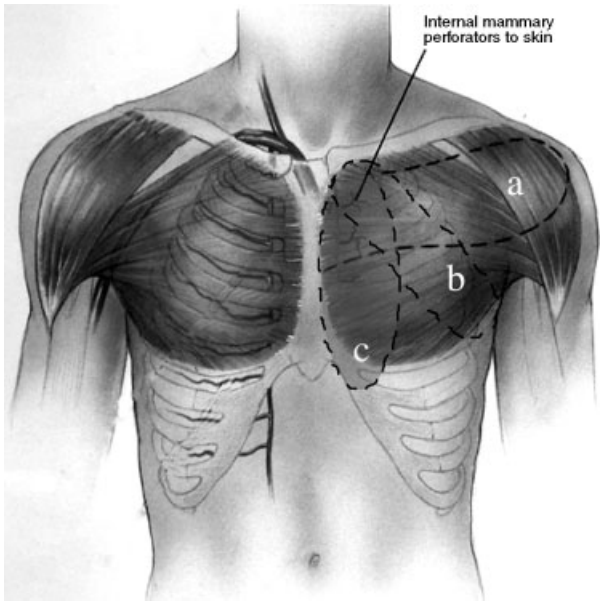


Figure 10 Deltopectoral flap design (a) is compared with just two options for raising an IMAP flap (b and c).

SUMMARY

As mentioned at the beginning of this article it is very important to adhere, where possible, to the principles of reconstruction that we have outlined. It is also very important not to abandon many of the traditional methods of reconstruction that have worked well in the past and continue to serve us well. The use of perforator flaps, however, adds a dimension to our reconstructions that allows greater flexibility in certain circumstances while at the same time adhering to the reconstructive principles.

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